

148-032

SERVICE INSTRUCTIONS



section FC

OUTPUT MULTIPLIER MIXER_OMM-2

P/N 1163-4010

(Used only in Type 1163 Synthesizers)

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GENERAL RADIO COMPANY

West Concord, Massachusetts

148-035



SECTION FC-1

INTRODUCTION

FC-1.1 GENERAL.

The information contained in this section supplements the over-all operation and instrument-maintenance instructions that appear in the front of this manual. This section has been prepared from a modular point of view. It is intended to furnish detailed information necessary for proper field maintenance (in the event of module failure), as indicated by paragraph 5.6 "System Trouble-Analysis".

Included in the following paragraphs are a physical description and signal-flow discussion of the module sufficient for comprehension, by experienced service personnel, of the principles of operation. A trouble-analysis procedure that will aid in isolation of defective circuits completes the section.

To facilitate parts identification, reference designators used in the text and on the photographs are the same as those that appear on the complete schematic diagram and in the parts list.

The service instructions are written to facilitate use of a properly functioning synthesizer as a basic test frame for the module. The instrument can be used to support the module, in a convenient bench-service position, and to supply it with power and test signals.

NOTE

First consideration should be given to the use of the widespread General Radio Company service organization to repair a defective module, particularly on an instrument still within the two-year warranty coverage.

Familiarity with the system principles of operation, as discussed in Section 4 of the front portion of this manual, is assumed as a basis for this section. Reference to other module sections should also be made as required.

FC-1.2 PURPOSE.

As noted in paragraph 4.7, the 30-c to 12-Mc output frequency of a Type 1163 Synthesizer is the result of a heterodyne between a frequency synthesized between 50 to 51 Mc/s and a frequency between 50 and 39 Mc/s.

The purpose of the OMM-2 unit is to accept from the DI-1 train a frequency adjustable between 5.0 and 5.1 Mc/s, multiply it by 10 (to 50 to 51 Mc/s), subtract



from it the 39 to 50 Mc/s (1-Mc steps) from the DI-4, amplify the result, and feed it to the Output Amplifier (P/N 1163-4040) through the sandwich-deck wiring. Refer to Section BB (on the Main Frame) for interconnecting circuits.

FC-1.3 DESCRIPTION (Figure FC-1).

The Output Mixer module OMM-2 plugs onto the rear of the sandwich deck of the Main Frame. Ground connection between the deck and the module case is made by a series of sheet-metal springs, fastened to the deck, that grip the bottom edges of the brass-strip rails which form the outside shell of the module. Two 4-40 screws, which mate with threaded inserts at each end of the rear surface, secure the unit in place.

Circular posts mounted on the exterior surfaces of the end plates of the unit serve during disassembly as pry points, by means of which the module can be raised vertically, until the grounding springs and banana plugs are disengaged.

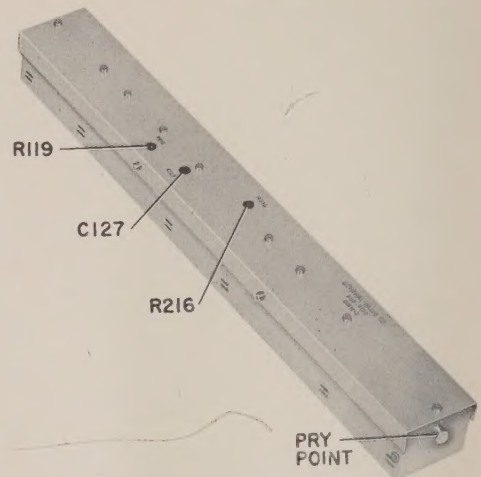


Figure FC-1. Output Multiplier Mixer module OMM-2, showing location of secondary controls.

SECTION FC-2

PRINCIPLES OF OPERATION

FC-2.1 SIGNAL FLOW.

The OMM-2 unit contains two etched-circuit boards. One is the X10 multiplier, which accepts the 5 to 5.1-Mc adjustable frequency from the DI-1 units. The other contains an amplitude leveler for the multiplied 50 to 51-Mc signal, the input and isolation amplifier for the signal from the DI-4 (from 39 to 50 Mc/s), the output mixer, low-pass filter, and output preamplifier. A block diagram of the unit appears in Figure FC-2. The complete electrical circuit is shown in Figure FC-6.

An adjustable signal, in the band from 5 to 5.1 Mc/s, enters at J101. It drives Q101, a buffer broadly tuned at 5.05 Mc/s by L101 and C106, which drives a X5 multiplier, Q102. There are three circuits tuned to 25.0/25.5 Mc/s (the coupled pair, L102/L103, and single-tuned L104, at the collector of Q103). Q104 is a doubler, with a double-tuned 50/51-Mc circuit (L106

and L107) that couples it to the double-tuned output amplifier, Q105.

In the output circuit of Q105, T101 is very lightly loaded on its one-turn secondary. Consequently it needs very small coupling of L109 for proper band-pass characteristics. Since there is some magnetic coupling between the coils, C124 is in a bucking connection to reduce the total coupling.

The 50 to 51-Mc leveler circuit includes the components associated with Q203 and CR203. CR203 rectifies the signal produced at the output of the X10 multiplier circuit, producing a bias at Q203 that is dependent on the level of the 50 to 51-Mc signal. Q203, a dc amplifier, uses the voltage produced by the ALC detector to control the bias of Q105 and thereby control the output signal (at 50-51 Mc/s) fed to R216. R216, in turn, is a potentiometer control that can be adjusted to give the desired drive to the output mixer.

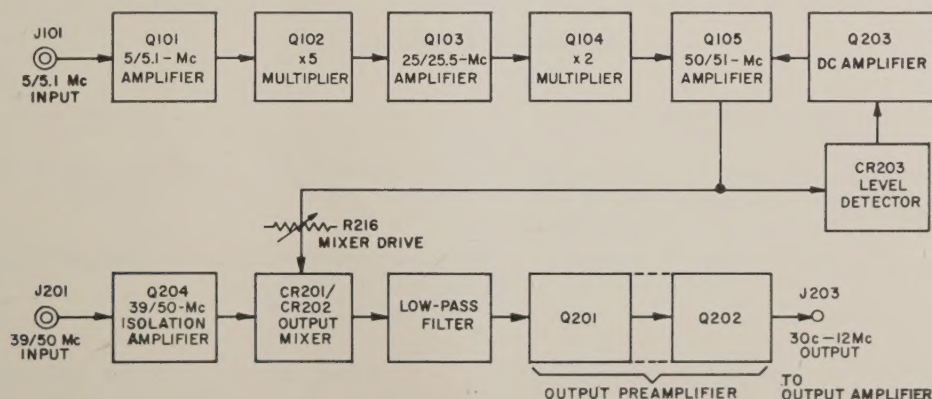


Figure FC-2. Block diagram of Output Multiplier-Mixer OMM-2.



The output mixer, comprising T201 and CR201/CR202, is driven by Q204 and the 50 to 51-Mc signal described above. Q204 is an isolation amplifier driven by the DI-4 signal (39-50 Mc/s) that prevents signals in the mixer from being fed back to the DI-4. The signal levels fed to the mixer differ in voltage level by about 10:1, the 39 to 50 Mc/s from Q204 being the higher signal. The output level from the mixer is thus controlled by the leveled 50 to 51-Mc input from T202.

The mixer load comprises R201 and the low-pass filter. The low-pass filter is an elliptic-function filter designed to have 0.1-dB ripple in the 0 to 12-Mc pass-band of the Type 1163 Synthesizer and fast roll-off to reject the 39 to 51-Mc signals also coming from the mixer. The filter has a minimum rejection of 65 dB, beyond 30 Mc/s. The elements in the filter are either fixed precision, or factory preadjusted, and cannot be adjusted in the field.

The signal at the filter, which is about 10 mV, drives the two-stage, wide-band preamplifier Q201 and Q202. Q201 is a common-emitter, emitter-compensated stage loaded by a common-emitter, shunt-feedback stage, Q202. The load resistor for Q202 is R401, the 250-ohm OUTPUT LEVEL control on the front panel of the Main Frame (refer to Section BB).

The high-frequency compensation for Q201 comprises R206 and C208. The high-frequency compensation for Q202 consists of R208 and L203. The low frequency cutoff is determined by C207, C210, and the associated impedances, but C209 and R208 increase the gain of Q202 at low audio frequencies. The actual shape of the response curve depends on the tolerances of these components, but a typical unit is nearly flat to 10 c/s. The low-frequency output response (of the Type 1163) is therefore largely determined by the Output Amplifier, P/N 1163-4040 (Section BB).

FC-2.2 INPUT AND OUTPUT CONNECTIONS.

Input and output connections to the OMM-2 unit are made through seven banana jacks and one ground lug.

The 5/5.1-Mc input from the DI-1 units comes into J101. The 39/50-Mc signal from the DI-4 arrives at J201, where a ground pin and spring (on the chassis) are used to keep signal paths short.

The +18 V dc arrives at two jacks, one for the multiplier, J102, and one for the preamplifier circuits, J202.

The output is carried to the front-panel OUTPUT LEVEL control via J203 and associated ground return, J204; refer to Section BB for details on this wiring. The impedance of OUTPUT LEVEL control R401 is sufficiently low so the cable capacitance can be ignored.

J103 connects with a banana plug in the sandwich deck, which is wired through an isolating resistor to subminiature jack J154 at the rear edge of the deck, to make available 50/51 Mc/s, at a low power level.

FC-2.3 CONTROLS.

There is provision for access through the top cover of the module for three secondary controls, C127, R216 and R119. These controls should rarely need adjustment.

C127 is a screwdriver-adjustable trimmer capacitor placed in the output tank circuit of the multiplier strip. It is useful for touch-up adjustments of the multiplier output to the mixer circuit.

The setting of R216 determines the drive to the preamplifier and the over-all synthesizer output. It should be set so that the synthesizer will deliver full rated output (2.0 V open circuit) at all frequencies.

R119 is a gain control in the X10 multiplier circuit, useful only when no leveling circuit is available, i.e. when this board is installed as part of the OMM-1 unit (Section FB). In the OMM-2 module, this control is set fully clockwise.

The frequency alignment of this module is slightly sensitive to the presence of the top cover. As a result, final touch-up adjustments must be made with the cover in place and the unit mounted on the Main Frame.

SECTION FC-3

SERVICE AND MAINTENANCE

FC-3.1 GENERAL.

If the system trouble-analysis procedures of Section 5 at the front of the manual indicate possible malfunction of the OMM-2 unit, the most positive verification of this suspicion is the substitution of another OMM-2 module.

Since there is but one OMM-2 module per instrument and since service spares may not be available, it will not always be possible to make the substitution. However, selected tests, and alignment procedures can be made in the field.

FC-3.2 TEST EQUIPMENT.

Table FC-1 lists the equipment recommended for service of the module; equivalent equipment may be substituted.

FC-3.3 REMOVAL AND DISASSEMBLY.

FC-3.3.1 REMOVAL FROM MAIN FRAME.

Removal of the module is accomplished as follows:

CAUTION

Turn power off before removal of module.

a. Remove the synthesizer from its case and remove the support bar across the back of the Main Frame chassis.

b. Remove the two 4-40 Phillips-head screws that attach the module to the rear wall of the chassis.

c. Insert a small screwdriver blade through the cutout in the right-hand rear corner of the synthesizer-chassis side wall, under the circular post on the CAD end of the module.

d. Insert a second screwdriver blade between the post at the opposite end and the top of the side wall.

e. Pry both ends up simultaneously, until the ground contacts and banana plugs are disconnected.

FC-3.3.2 REMOVAL OF COVER.

Cover removal is accomplished as follows:

a. Dismount the module from the synthesizer chassis (paragraph FC-3.3.1).

TABLE FC-1
TEST EQUIPMENT RECOMMENDED

<u>Function</u>	<u>Type</u>	<u>Minimal Characteristics</u>
Electronic Voltmeter (VTVM)	GR 1806-A	2% accuracy; ac and dc capabilities; 1 to 55-Mc range; 0.2 V sensitivity; probe capacitance 2.0 pF maximum.
Oscilloscope	Tektronix Model 543 (with C/A plug-in and P6006 10x passive probe).	20 Mc/s, 0.5 V/cm, with 8 pF probe capacitance.
Standard Sweep Frequency Generator	GR 1025-A	0.5% calibration accuracy.

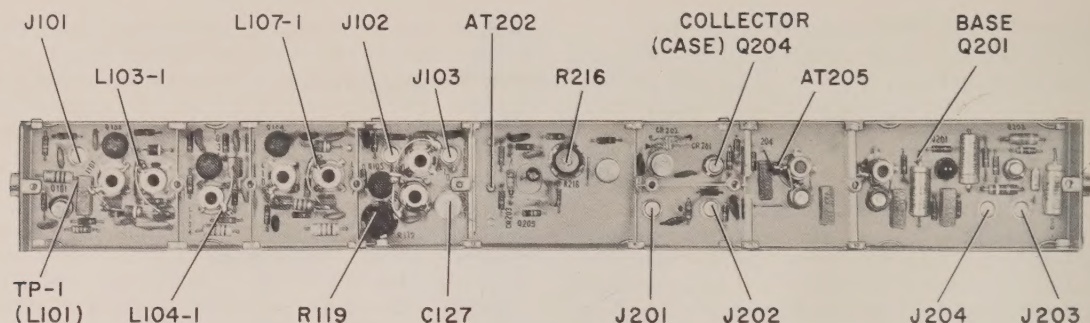


Figure FC-3. Interior view of OMM-2 module showing test points and secondary adjustment controls.

- b. Remove the nine 4-40 screws in the top of the module and the two from each side to release the cover.
- c. Lift the cover off and retain it and the screws.

FC-3.3.3 REASSEMBLY AND INSTALLATION.

Installation of the cover is the reverse of the above. When reinstalling the module on the chassis be sure that its bottom rail engages the grounding springs in such a way that the springs are not damaged. Press down until the module is seated firmly in place.

FC-3.4 TROUBLE ANALYSIS.

FC-3.4.1 GENERAL (Figures FC-3 and FC-6).

Malfunction within an OMM-2 module, as indicated by the system trouble-analysis procedures found in Section 5 at the front of the manual, can be isolated further here. The indications obtained from external connectors and test points on the synthesizer can be used to localize the difficulty to a particular circuit. In the procedures that follow, the top cover must be removed to permit access to interior test and adjustment points (refer to paragraph FC-3.3.2). See Figure FC-3 for locations of interior test points and adjustment controls.

In the performance of these tests, the synthesizer Main Frame chassis is used to support the unit, and the other modules are used to power it and to supply loads for its outputs. All DI modules or bridging units should be in place.

With the case removed from the synthesizer and the mixer unit installed (less cover), the instrument can be operated on the test bench.

FC-3.4.2 POWER-SUPPLY.

Measure power-supply input voltage at J102 and J202. This voltage should be $+18 \pm 0.2$ Vdc. If not, tests should be made elsewhere in the system to correct this defect (refer to Sections BB and GA).

FC-3.4.3 SIGNAL CHECKS.

The OMM-2 is not operating properly if the output at J203 (normally 0.8 V) is absent, low, or distorted, while both inputs at J101 (5/5.1 Mc/s) and J201 (39/50 Mc/s) are present, at an approximate level of 0.3 V, rms. Set the front-panel OUTPUT LEVEL control fully CCW for this test.

Absence or low level of output signal may be due to failure of the multiplier section, or isolation amplifier, Q204. A check of voltages is given in Table FC-2. Low voltage at J103 will lower the mixer output; low voltage at the collector of Q204 will distort the output signal.

If no indication can be obtained at either J103 or AT202, proceed sequentially with the probe down the capacitively coupled tuned circuits, from the center toward the input buffers. The test point is always terminal 1 of L109, L107, L106, L104, L103 and L102. The stage immediately following the last tank circuit at which rf can be found is very likely defective.

If signals are present at both sides of the mixer, measure the output of the mixer at the output of the low-pass filter with a sensitive VTVM at L202 pin 2, to check operation of the mixer. Observations at test points in this end of the module should isolate trouble to a defective stage. Table FC-2 gives values for the signals at various points.

At any stage giving abnormal indications, in the course of preceding procedures, check the dc voltages of the transistors, by use of a VTVM (with probe), on the component side of the etched-circuit board, while

TABLE FC-2
TROUBLE-ANALYSIS (Figure FC-3)

Step	Section	Test Point	Indication (V, rms)
1	Mixer-Preamp	J203	0.7-1.0
2		Base, Q201	.008-.010
3		Coll. (case) Q204	2.0-3.0
4		J103	0.8-1.0
5	X10 Multiplier	L107-1	4.0
6		L104-1	4.0
7		L103-1	2.3
8		TP1 (L101)	1.9

NOTES:

Type 1806-A with ac probe used for all measurements but step 2.
Reference levels only; subject to fairly wide variations.
Determination of the presence or absence of signals rather than their amplitudes will permit localization of trouble.

TABLE FC-3
DC VOLTAGE LEVELS
(Figure FC-3)

<i>Transistor</i>	<i>Collector</i>	<i>Base</i>	<i>Emitter</i>
Q101	0	16.2	16.4
Q102	16.0	0	1.9
Q103	17.1	3.0	2.4
Q104	17.1	1.0	1.6
Q105	17.8	0.4-1.5*	1.3
Q201	7.9	0.85	.076
Q202	3.6	7.9	8.5
Q203	0.4-1.5*	0.5	.02
Q204	0	12.8	13.5

NOTES:

Unit operating with all inputs, installed in chassis, no cover.

Voltages measure with Type 1806-A dc + position. These are typical readings and they are dependent on rf levels; variations of $\pm 15\%$ are to be expected.

*Dependent on gain in ALC circuit.

the unit is installed in the chassis. Appropriate values are given in Table FC-3.

FC-3.5 ADJUSTMENT PROCEDURES.

FC-3.5.1 GENERAL (Figure FC-3).

If the trouble-analysis procedures of paragraph FC-3.4 indicate marginal performance of a circuit function, or if repairs or replacements have been made, adjustments of circuits in the OMM-2 unit may be required.

NOTE

A complete alignment of the X10 multiplier section is not possible without a sweep-generator setup and a special cover.

If frequency-insensitive components have been replaced, no alignment will be required. Repairs in the X10 multiplier section can affect the instrument output-frequency response and the output level; repairs in the remainder of the module may affect the level and distortion of the output-frequency.

FC-3.5.2 X10 MULTIPLIER SECTION CHECKS.

To test the X10 multiplier and ALC circuit section, after replacement of frequency-insensitive components, proceed as follows:

a. Set the synthesizer to 5,000,000-Mc output frequency and OUTPUT LEVEL to 2.0 V.

b. Set the MONITOR switch to OUTPUT VOLTS.

c. Rotate the dial of the X100 KC DI-1 through all 10 positions (5.0 to 5.9 Mc/s) and observe the MONITOR meter.

d. If the output-level indication does not vary more than a fraction of a division (1 division = 0.2V), it can be assumed that the X10 multiplier and leveler circuits are operating properly.

e. If larger variations are observed, realignment at the factory is required.

FC-3.5.3 MIXER PREAMP TESTS AND ALIGNMENT.

NOTE

The following information assumes that the X10 multiplier circuit and ALC control are in proper operating condition (paragraph 3.5.2).

The only adjustment in this section is the mixer drive, R216. This control is adjusted to give 2 volts open-circuit at the synthesizer OUTPUT jack, when the OUTPUT LEVEL control is full CW. If the voltage at J203, resulting from this adjustment, is greater than 0.9 V, rms, at the synthesizer output frequency, an additional check should be made to see that no malfunction exists in the Output Amplifier (refer to Section BB).

If the output characteristic of the synthesizer is insufficiently flat, and if the voltage at AT202 is within limits over the DI-1 adjustment range (paragraph 3.5.2), interconnections at AT204 and AT205 may be opened and a response check made of the low-pass filter and preamplifier section only. A drive signal of 9-11 mV should result in an output of 0.8 V at J203; use the sweep-frequency generator. With a constant signal level at AT205, the level at J203 should not vary more than ± 0.5 dB from 50 c/s to 12 Mc/s. The OUTPUT LEVEL control on the front panel of the synthesizer should be fully CCW for this measurement.

FC-3.6 REPAIRS AND REPLACEMENTS.

If subnormal circuits don't respond to adjustments indicated in the alignment procedures, use the schematic diagram, Figure FC-6, to localize the trouble area; replace defective detail parts. The parts list gives pertinent descriptive information on parts used and reference designators appearing there are the same as those used on schematics and photos. The composite view of the etched-circuit board presented in Figures FC-4 and FC-5 show the locations of all detail parts in the module. These figures can also be used to find top-of-board contacts with transistor leads.

Basing diagrams for the transistor types used are given on the schematic diagrams. The collector lead is identified by a dot on the foil side of the etched-circuit boards.

PARTS LIST

REF NO	DESCRIPTION	PART NO	REF NO	DESCRIPTION	PART NO
CAPACITORS			RESISTORS(Cont)		
C101	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R104	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225
C102	Ceramic, 0.47 μ F $\pm$ 20% 25 V	4400-2054	R105	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225
C103	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R106	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C104	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R107	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C105	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	R108	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475
C106	Mica, 75 pF $\pm$ 5% 500 V	4700-0375	R109	Composition, 4.7 k Ω $\pm$ 5% 1/4 W	6099-2475
C107	Ceramic, 1.5 pF $\pm$ 5% 500 V	4400-0150	R110	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105
C108	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R111	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C109	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	R112	Composition, 220 Ω $\pm$ 5% 1/4 W	6099-1225
C110	Ceramic, 10 pF $\pm$ 5% 500 V	4400-1100	R113	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335
C111	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R114	Composition, 22 k Ω $\pm$ 5% 1/4 W	6099-3225
C112	Mica, 200 pF $\pm$ 5% 500 V	4640-0650	R115	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155
C113	Ceramic, 16 pF $\pm$ 5% 500 V (NPO)	4410-0165	R116	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C114	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R117	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155
C115	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	R118	Composition, 100 k Ω $\pm$ 5% 1/4 W	6099-4105
C116	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	R119	Potentiometer, composition 25 k Ω $\pm$ 20%	6040-0800
C117	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R120	Composition, 100 Ω $\pm$ 5% 1/4 W	6090-1105
C118	Ceramic, 0.33 pF $\pm$ 5% 500 V	4400-0033	R121	Composition, 330 Ω $\pm$ 5% 1/4 W	6090-1335
C119	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	R201	Composition, 200 Ω $\pm$ 5% 1/4 W	6099-1205
C120	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	R202	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C121	Ceramic, 6.8 pF $\pm$ 10% 500 V	4400-0800	R203	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155
C122	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	R204	Composition, 8.2 k Ω $\pm$ 5% 1/4 W	6099-2825
C123	Mica, 51 pF $\pm$ 5% 500 V	4640-0316	R205	Composition, 1 k Ω $\pm$ 5% 1/4 W	6099-2105
C124	Ceramic, 1.0 pF $\pm$ 5% 500 V	4400-0101	R206	Composition, 18 Ω $\pm$ 5% 1/4 W	6099-0185
C125	Ceramic, 0.001 μ F +80-20% 500 V	4404-2109	R207	Composition, 390 Ω $\pm$ 5% 1/2 W	6100-1395
C126	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	R208	Composition, 3.9 k Ω $\pm$ 5% 1/4 W	6099-2395
C127	Trimmer, 5.5 to 18 pF 350V	4910-2044	R210	Composition, 3.3 k Ω $\pm$ 5% 1/4 W	6099-2335
C128	Ceramic, 10 pF $\pm$ 5% 500 V (N30)	4411-0105	R211	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C201	Mica, 121 pF $\pm$ 1% 500 V	4710-0031	R212	Composition, 10 k Ω $\pm$ 5% 1/4 W	6099-3105
C202	Trimmer, 0.8 to 8.5 pF	4910-1100	R213	Composition, 680 Ω $\pm$ 5% 1/4 W	6099-1685
C203	Ceramic, 10 pF $\pm$ 5% 500 V	4411-0105	R214	Composition, 100 Ω $\pm$ 5% 1/4 W	6099-1105
C204	Mica, 221 pF $\pm$ 1% 500 V	4710-0400	R215	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155
C205	Trimmer, 0.8 to 8.5 pF	4910-1100	R216	Potentiometer, composition 500 Ω $\pm$ 20%	6040-0300
C206	Mica, 140 pF $\pm$ 1% 500 V	4710-0140	R217	Composition, 560 Ω $\pm$ 5% 1/4 W	6099-1565
C207	Electrolytic, 180 μ F $\pm$ 20% 6 V	4450-5617	R219	Composition, 2.2 k Ω $\pm$ 5% 1/4 W	6099-2225
C208	Mica, 1200 pF $\pm$ 5% 100 V	4700-0685	R220	Composition, 5.6 k Ω $\pm$ 5% 1/4 W	6099-2565
C209	Electrolytic, 4.7 μ F $\pm$ 20% 10 V	4450-4700	R221	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1105
C210	Electrolytic, 120 μ F $\pm$ 20% 10 V	4450-5616	R222	Composition, 47 Ω $\pm$ 5% 1/4 W	6099-0475
C211	Electrolytic, 47 μ F $\pm$ 20% 20 V	4450-5614	R223	Composition, 15 Ω $\pm$ 5% 1/4 W	6099-0155
C212	Ceramic, 10 pF $\pm$ 10% 500 V (N30)	4411-0105	R224	Composition, 33 Ω $\pm$ 5% 1/4 W	6099-0335
C213	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	R225	Composition, 150 Ω $\pm$ 5% 1/4 W	6099-1155
C214	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	TRANSISTORS		
C215	Ceramic, 0.01 μ F +80-20% 50 V	4401-3100	Q101	Type 2N2188	8210-1045
C216	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	Q102	Type 2N2218	8210-1028
C217	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	Q103	Type 2N2218	8210-1028
C218	Ceramic, 0.001 μ F $\pm$ 10% 500 V	4405-2108	Q104	Type 2N2218	8210-1028
C219	Ceramic, 150 pF $\pm$ 5% 500 V	4404-1155	Q105	Type 2N2218	8210-1028
INDUCTORS			Q201	Type 2N918	8210-1066
L101	Choke, rf, 10 μ H $\pm$ 10%	4300-2200	Q202	Type 2N3250	8210-1089
L102	Adjustable	1160-2400	Q203	Type SE4002	8210-1077
L103	Adjustable	1160-2410	Q204	Type 2N3250	8210-1089
L104	Adjustable	1160-2400	MISCELLANEOUS		
L105	Adjustable, 22 μ H $\pm$ 10%	4300-2600	CR201	DIODE, Semiconductor type 1N994	6082-1017
L106	Adjustable	1160-2400	CR202	DIODE, Semiconductor type 1N994	6082-1017
L107	Adjustable	1160-2410	CR203	DIODE, Semiconductor type 1N995	6082-1002
L108	Adjustable, 22 μ H $\pm$ 10%	4300-2600	J101	through JACK, Etched-circuit, type	1160-6110
L109	Adjustable	1160-2400	J103		
L201	Adjustable	1163-2240	J201		
L202	Adjustable	1163-2231	through JACK, Etched-circuit, type		
L203	Adjustable, 3.9 μ H $\pm$ 10%	4300-1500	J204		
RESISTORS			T101	TRANSFORMER, Adjustable	1160-2390
R101	Composition, 1.5 k Ω $\pm$ 5% 1/4 W	6099-2155	T201	TRANSFORMER, Adjustable	5000-2603
R102	Composition, 18 k Ω $\pm$ 5% 1/4 W	6099-3185	T202	TRANSFORMER, Adjustable	5000-2402
R103	Composition, 330 Ω $\pm$ 5% 1/4 W	6099-1335			

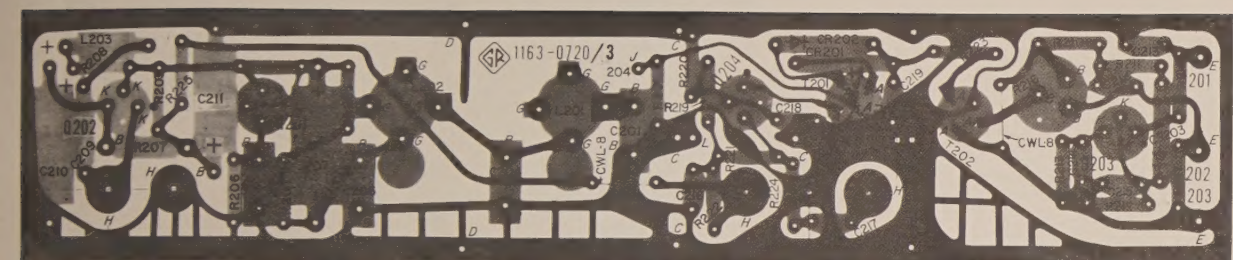


Figure FC-4. Etched-circuit board of Preamplifier (P/N 1163-2720).

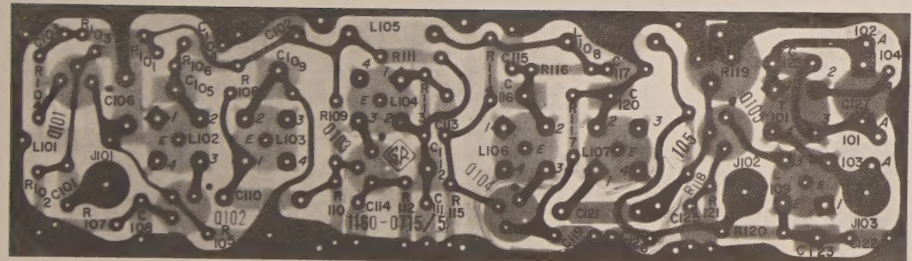
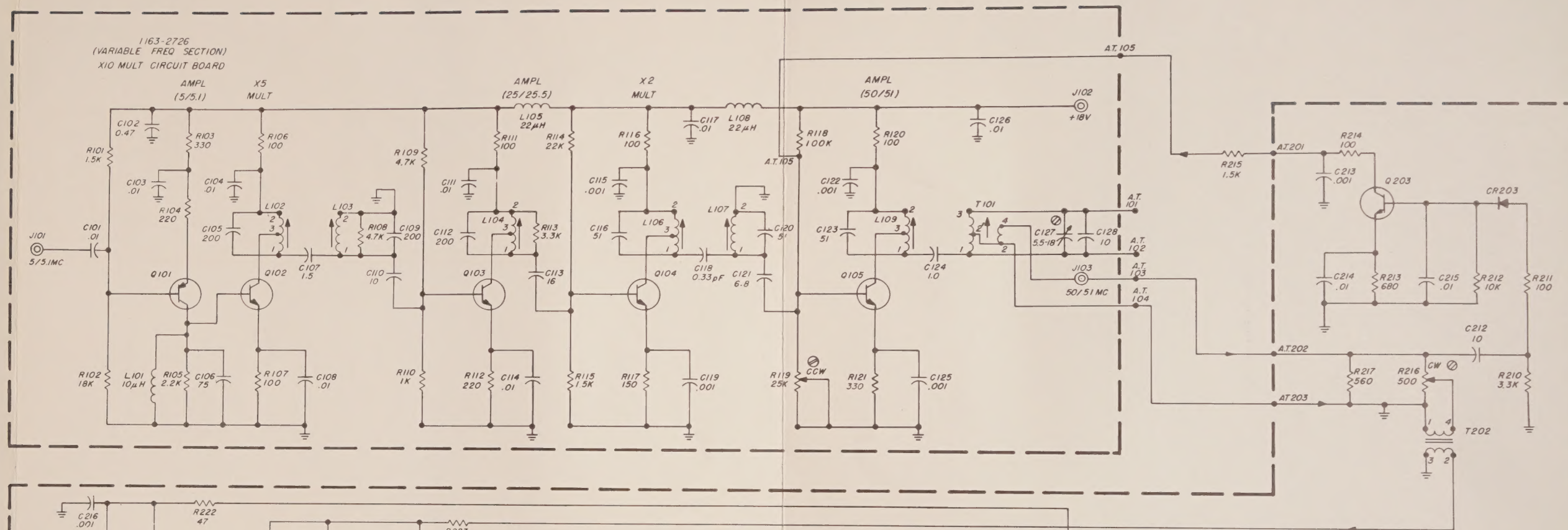
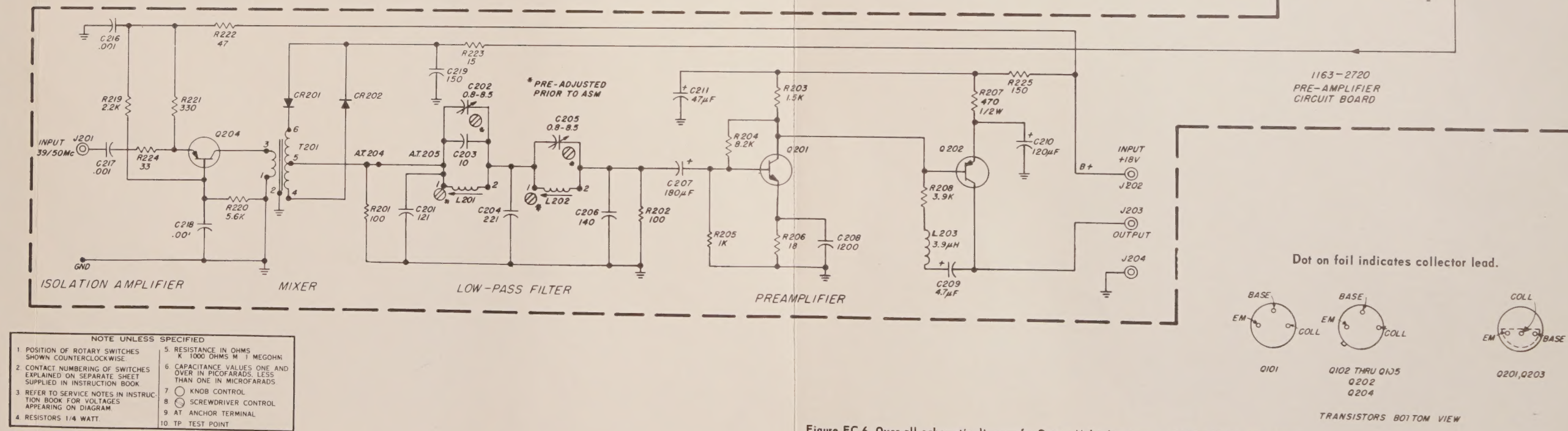


Figure FC-5. Etched-circuit board of X10 Multiplier (P/N 1163-2726).

NOTE: The number appearing on the foil side is not the part number.



- NOTE UNLESS SPECIFIED
1. POSITION OF ROTARY SWITCHES SHOWN COUNTERCLOCKWISE
 2. CONTACT NUMBERING OF SWITCHES EXPLAINED ON SEPARATE SHEET SUPPLIED IN INSTRUCTION BOOK
 3. REFER TO SERVICE NOTES IN INSTRUCTION BOOK FOR VOLTAGES APPEARING ON DIAGRAM
 4. RESISTORS 1/4 WATT
 5. RESISTANCE IN OHMS X 1000 OHMS M 1 MEGOHM
 6. CAPACITANCE VALUES ONE AND OVER IN PICO FARADS, LESS THAN ONE IN MICROFARADS
 7. KNOB CONTROL
 8. SCREWDRIVER CONTROL
 9. AT ANCHOR TERMINAL
 10. TP TEST POINT

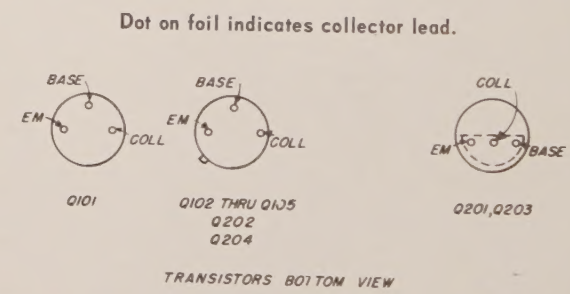
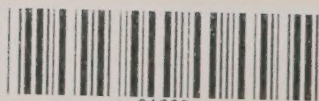


Figure FC-6. Over-all schematic diagram for Output Multiplier-Mixer - OMM-2 (P/N 1163-4010).



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